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Review Paper

Prevalence of intestinal parasitic infections among communities living in different habitats and its comparison with one hundred and one studies conducted over the past 42 years (1970 to 2013) in Malaysia

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Abstract. Intestinal parasitic infections are among the most common diseases affecting mankind causing major public health problems to billions of people living in developing countries. The aim of this study is to determine the prevalence of intestinal parasites in various communities residing in different habitats in Malaysia and compare the findings with 101 studies conducted over the past 42 years (1970-2013). A cross-sectional study design was conducted with the aid of a questionnaire to collect relevant information about the study population. Faecal samples were examined using the direct smear and formal ether sedimentation techniques. A total of 342 children were examined amongst whom 24.6% were positive for intestinal parasitic infections. Results showed that 32.3% of rural children, 20.6% of urban squatters and 5.4% of children from flats were positive for one or more parasites. The most common parasite encountered was *Trichuris trichiura* (20.2%) followed by *Ascaris lumbricoides* (10.5%) and hookworm (6.7%). No case of hookworm was reported in urban children whereas 12.2% of rural children were positive. The most common protozoan parasite detected was *Entamoeba coli* (3.2%) followed by *Giardia intestinalis* (1.8%), *Entamoeba histolytica (*1.8%) and *Blastocystis hominis* (1.2%). Nearly one-fifth (18.4%) of the children had single infection followed by double (12.0%) and triple infections (1.2%). Orang Asli (indigenous) children (44.3%) had the highest infection rate followed by Indians (20.2%), Malays (14.0%) and Chinese (11.9%). Twenty-eight studies carried out on plantation communities with regards to intestinal parasitic infections in Malaysia from 1970 to 2013 showed a steady decline in the prevalence rate ranging from 95.0% in the seventies to 37.0 % in 2012. Intestinal parasitic infections were more common in Orang Asli communities with prevalence ranging from over 90% in the seventies and fluctuating below 70% in most studies between 2000 to 2013 except for two studies that showed a prevalence of 98.2% and 100%. The prevalence rate among urban squatters, urban residents and those living in flats showed dramatic decrease in prevalence rate.

INTRODUCTION

Since the dawn of man, intestinal parasitic infections still continue to be the most common cause of chronic infections, in communities living in resource poor countries situated in the tropics and sub tropics. These diseases cause great sufferings in areas of high endemicity in underprivileged communities and have recently been categorized as one of the "Neglected Tropical Diseases" (NTDs) by World Health Organization. They are classified as NTDs because they are characterized by little attention from policy-makers, lack of priority within health

strategies, inadequate research, limited resource allocation and few interventions (WHO, 2010). As part of the Millennium Development Goals, member countries of WHO including Malaysia have pledged to address the problem in collaboration with multinational pharmaceutical companies who have committed to provide anthelminthic drugs free of charge or at reduced cost. The global movement against NTD with primary focus on Soil-transmitted helminths (STH) undertaken by national governments and relevant stake holders are determined to stem the spread of this infection amongst the lower income underprivileged communities. Despite attempts to control or reduce the prevalence of intestinal parasites in these affected communities, the parasites have continued to show remarkable resilience to maintain a stable population in their hosts (Anderson & May, 1985). Endemic areas where infections exist are in farming, fishing, plantation, aboriginal communities as well as urban slums (Bisseru & Aziz., 1970; Che Ghani *et al*., 1989; Dissanaike *et al*., 1977; Sinniah *et al.*, 1979; Kan & Poon., 1987; Sinniah *et al.*,1992; Norhayati *et al.*, 1995; Al-Mekhlafi *et al.*, 2007; Sinniah *et al.*, 2010; Lim *et al.*, 2012). With industrialization and urbanization taking place in many developing countries such as Africa, South America, Asia including Malaysia, there is continuous migration of population from rural to urban areas as well as mass influx of legal and illegal immigrants from neighbouring countries who are attracted to big cities to seek a better life. This sudden influx of people has contributed to the mushrooming of numerous mega urban slums where the environment is conducive for the transmission of intestinal pathogens. Recent estimates indicate that there are more than 1.5 billion people or 24% of the world's population infected with at least one species of soil-transmitted helminths consisting of 807-1221 million cases of *Ascaris lumbricoides*, 604-795 million cases of *Trichuris trichiura* and 576-740 million cases of hookworm (Albonico *et al.*, 2008; WHO., 2002; WHO., 2012). World Health Organization (1997) states that there are 50 million cases of amoebiasis with 40,000-100,000 deaths annually. In Malaysia several studies have shown that the prevalence of intestinal parasites among the Orang Aslis (indigenous), plantation workers and rural population are still widespread. The present study was carried out to determine the prevalence of intestinal parasites among children living in different habitats (urban and rural areas) and review the data with studies done over the past 42 years (1970 to 2013) according to the type of communities and populations surveyed. The effect of changes in the socioeconomic status and the living environment of the population are studied in relation to intestinal parasites in Malaysia.

MATERIALS AND METHODS

A cross-sectional study design was conducted on school children selected from urban slum, flat and rural areas (plantations and villages). Prior consent was obtained from parents before collection of stool samples. Questionnaires were distributed to the parents to gather the relevant information related to the study. Labeled plastic containers for collection of stool samples were distributed to 600 children who initially agreed to participate in the study but only 342 were returned. The stool samples were examined using formalin-ether sedimentation and direct smear methods. Faecal samples suspected for *Cryptosporidium sp.* were stained using the modified acid fast stain (Kinyoun stain, Scott, 1998). No attempt was made to determine the prevalence of *Enterobius vermicularis* infection. Samples with rhabditiform larvae were cultured using the filter paper culture technique (Suzuki, 1977) to confirm whether the larvae were hookworm or *Strongyloides stercoralis* species. Published data on intestinal parasitic infections in Peninsular Malaysia from 1970 to June 2013 were searched using various sources like websites, Pub Med and journals. The data were extrapolated for comparing the trends in the prevalence of intestinal parasites over the past 42 years in the Orang Asli (indigenous group), plantation, urban slums, fishing communities and flat dwellers. Analysis was

done on each variable such as locality, ethnic groups, type of parasites and number of infections.

RESULTS

Of the 342 stool samples examined, 24.6% were positive for intestinal parasites. The infection was more common among Orang Asli (44.3%), followed by Indians (20.2%), Malays (14.0%) and Chinese (11.9%) as shown in Table 1. The common intestinal parasites detected was *Trichuris trichiura* (20.2%) followed by *Ascaris lumbricoides (*10.5%), hookworm (6.7%), *Entamoeba coli* (3.2%), *Giardia intestinalis* (1.8%), *Entamoeba histolytica* (1.8%) and *Blastocystis hominis* (1.2%) as shown in Table 1. Intestinal parasitic infection was more common among those living in rural areas (32.3%) followed by urban squatters (20.6%) and least among those residing in flats or apartments (5.4%) as shown in Table 2. Single infections (18.4%) were more common than double (12.0%) and triple (1.2%) infections as shown in Table 3. The overall prevalence of intestinal parasites among the study population living in different localities of Malaysia was compared with studies conducted earlier from 1970 to 2013. The results of twenty four studies in Orang Asli showed that the prevalence of intestinal parasites was high, ranging between 91.3 % to 99.2% in the seventies, fluctuating between 70% to 44.3% from 1995 to 2013 with the exception of two studies by Al-Mehklafi *et al* in 2006 & 2007 that showed a prevalence of 100% and 98.2% respectively as shown in

Table 1. Distribution of intestinal parasitic infections in different ethnic groups

Ethnic group	Orang Asli	Malays	Chinese	Indians	Total
No. Exam.	106	93	59	84	342
No. Pos.	47	13	7	17	84
% Pos.	44.3	14.0	11.9	20.2	24.6
Parasites					
E. histolytica	5 (4.7%)	1(1.1%)	0 (0%)	0 (0%)	6 (1.8%)
E. coli	3 (2.8%)	2 (2.2%)	2 (3.4%)	4 (4.8%)	11 (3.2%)
G. intestinalis	5 (4.7%)	0 (0%)	0 (0%)	1 (1.2%)	6 (1.8%)
B. hominis	2 (1.9%)	2 (2.2%)	0 (0%)	0(0%)	4 (1.2%)
A. lumbricoides	18 (17.0%)	7 (7.5%)	2 (3.4%)	9 (10.7%)	36 (10.5%)
T. trichiura	51 (48.1%)	4 (4.3%)	3 (5.1%)	12 (14.3%)	69 (20.2%)
Hookworm	22 (20.8%)	1 (1.1%)	0 (0%)	0 (0%)	23 (6.7%)

Table 2. Prevalence of intestinal parasitic infection in urban squatter, flat and rural schoolchildren

Habitat	Rural	Flats	Squatter
No. exam	189	56	97
No Pos. (% Pos.)	61 (32.3%)	3 (5.4%)	20 (20.6%)
Parasites			
E. histolytica	5 (2.6%)	–	1 (1.0%)
E. coli	5 (2.6%)	1 (1.8%)	5 (5.2%)
G. intestinalis	3 (1.6%)	0 (0%)	3 (3.1%)
B.hominis	0 (0%)	1 (1.8%)	3 (3.1%)
A.lumbricoides	24 (12.7%)	2 (3.6%)	12 (12.4%)
T. trichiura	53 (28.0%)	2 (3.6%)	13 (13.4%)
Hookworm	23 (12.2%)	0 (0%)	0 (0%)

Table 3. Multiplicity of intestinal parasitic infections in schoolchildren examined

No. of intestinal parasite infection with	No. Pos.	% Pos.
Single		
A. lumbricoides	15	4.4
T. trichiura	34	9.9
Hookworm	2	0.6
B. hominis	1	0.3
E. coli	5	1.5
E. histolytica	3	0.9
G. intestinalis	3	0.9
Total single parasitic infection	63	18.4
Two Parasites		
A. lumbricoides + *T. trichiura*	13	3.8
A. lumbricoides + Hookworm	5	1.5
A. lumbricoides + *B. hominis*	1	0.3
B. lumbricoides + *E. coli*	1	0.3
T. trichiura+ Hookworm	13	3.8
T. trichiura + *G. intestinalis*	1	0.3
T. trichiura + *E. coli*	4	1.2
E. histolytica + *G. intestinalis*	1	0.3
E. coli + *B. hominis*	1	0.3
G. intestinalis + *B. hominis*	1	0.3
Total with two parasites	41	12.0
Three parasites		
A. lumbricoides + *T. trichiura* + Hookworm	2	0.6
A. lumbricoides + *T. trichiura* + *E. histolytica*	1	0.3
Hookworm + *T. trichiura* + *E. histolytica*	1	0.3
Total with three parasites	4	1.2

Table 4. The highest prevalence rate (92.1%) recorded in the plantation sector was in 1983. Analysis of twenty eight studies conducted in the rural population (plantation and kampung (village) over the past 42 years showed that the prevalence rate fluctuated mainly between 32.3% to 70%, as shown in Table 5. A review of eighteen studies among slum dwellers showed that the prevalence rate fluctuated from as high as 90.9 % in 1978 to 20.6% in the current study. Since the 1980s, the prevalence rate mostly fluctuated below 70% as shown in Table 6. Sixteen studies were analysed in the urban dwellers (excluding squatters) that was conducted in 42 years and results indicate that ten out of sixteen studies showed prevalence of 50% or less as shown in Table 7. Analysis of seven studies among flat dwellers showed a decreasing trend in the prevalence rate ranging from as high as 57% in 1983, to as low as 8.1% and 5.1% between 2002 and 2013 as shown in Table 8. Only eight studies were conducted among the fishermen and their families between 1969 and 1988 that showed a decrease in prevalence from as high as 98% in 1969 decreasing to 54.2% in 1988 as shown in Table 9.

DISCUSSION

The social and economic impact of chronic gastro-intestinal parasites on human development (e.g. malabsorption, malnutrition, stunted growth and chronic anaemia) and capacity (e.g. diminished cognition, missed school and inability to

Table 4. Prevalence of intestinal parasitic infections reported in Orang Asli from 1970 to 2013

No. examined	Percentage Pos. (%)	Type of infection	Authour/ Year of study
110	87.3	STH + Protozoa	Bisseru & Aziz, 1970
1273	91.3	STH + Protozoa	Dunn, 1972
126	99.2	STH + Protozoa	Dissanaike *et al.*, 1977
59	61.5	STH + Protozoa	Karim *et al.*, 1995
ns	13.0	STH	Norhayati *et al.*, 1995
93	79.6	STH + Protozoa	Mohd Sham, 1996
84	79.8	STH	Rahmah *et al.*, 1997
205	92.0	STH	Norhayati *et al.*, 1997
ns	29.0	STH	Noor Hayati *et al.*, 1998
259	56.0	STH	Zulkifli *et al.*, 1999
183	69.4	STH	Zulkifli *et al.*, 2000
159	55.3	STH	Ghani *et al.*, 2002
281	26.0	STH	Nor Aini *et al.*, 2004
368	98.2	STH	Al-Mekhlafi *et al.*, 2005
281	98.2	STH	Al-Mekhlafi *et al.*, 2006
292	100	STH	Al-Mekhlafi *et al.*, 2007
74	59.5	STH	Hakim *et al.*, 2007
130	72.3	Protozoa	Noor Azian *et al.*, 2007
120	65.8	STH	Al-Mekhlafi *et al.*, 2008
75	77.3	STH + Protozoa	Sinniah *et al.*, 2010
254	93.7	STH	Abdullah Ahmed *et al.*, 2012
77	50.6	STH + Protozoa	Sinniah *et al.*, 2012
484	78.1	STH	Nasr *et al.*, 2013
106	44.3	STH + Protozoa	Sinniah (current)

work) can destabilize endemic communities and reinforce local poverty. This can consequently hinder national and regional economic development due to poverty (Hotez *et al.*, 2008; Hotez *et al.*, 2009 & Harhay *et al.*, 2010). A review of one hundred and one published articles on intestinal parasitic infections in Malaysia (1970 to 2013) showed that intestinal parasitic infections continue to be a public health problem especially among the poverty- stricken communities. The prevalence of STH was highest among the Orang Asli followed by plantation and rural communities, squatter, fishing communities, new villages and least among the flat dwellers. Current study showed that 24.6% of the population was positive for at least one intestinal parasite. It was more common among Orang Asli followed by Indians, Malays and Chinese. The differences in the distribution of intestinal parasites among the different ethnic group does not reflect any racial predisposition or susceptibility to infection but is more closely related to their living conditions and life-style. The cultural habits of the Orang Asli, Indians and Malays using their fingers to eat play an important role in the transmission of intestinal parasites (Kan,1984; Sinniah,1984, Lim *et al.*, 2009). The current study showed a low prevalence rate amongst the groups compared to previous studies (Dunn, 1972; Bisseru & Aziz, 1970; Dissanaike *et al.*, 1977; Chia *et al.*, 1978; Lo *et al.*, 1979; Norhayati *et al.*, 1997; Al-Mekhlafi *et al.*, 2005 & 2007; Sinniah *et al.*, 2002; Ngui *et al.*, 2011; & Nasr *et al.*, 2013). Low infection rate may indicate better awareness, improvement in the socioeconomic status in the population and success of the Primary Health Care services instituted by the Ministry of Health Malaysia. *Trichuris trichiura* is the most prevalent nematode because in heavy infection better cure rates can only be achieved with multiple

Table 5. Prevalence of intestinal parasitic infections among rural communities 1970-2013

No. exam.	% Pos.	Type of Parasite	Authour/Year of study
183	90.0	STH + Protozoa	Bisseru & Aziz, 1970
202	63.4	STH	Lie *et al.*, 1971
150	82.7	STH + Protozoa	Sinniah *et al.*, 1979
834	95.0	STH	Lo *et al.*, 1979
562	36.3	STH	Zahedi *et al.*, 1980
25,246	39.6	STH	Kan, 1982
342	92.1	STH	Ramalingam *et al.*, 1983
1,511	73.0	STH	Kan, 1983
731	66.4	STH	Sinniah, 1984
422	81.0	STH	Kan, 1984
342	38.9	STH	Kan,1984
949	83.6	STH	Subramaniam & Sinniah, 1985
11,874	41.1	STH	Kan & Poon, 1987
641	79.4	STH	Sinniah & Chew, 1988[a]
819	51.0	STH	Kan, 1989
134	92.5	STH	Sinniah & Chew, 1990
1203	83.2	STH	Li, 1990
319	62.7	STH	Sinniah *et al.*, 1992
103	81.2	STH	Thomas *et al.*, 1992
671	63.2	STH + Protozoa	Sinniah *et al.*, 1993
456	62.9	STH + Protozoa	Rajeswari *et al.*, 1994
ns	60.3	STH	Oothuman *et al.*, 1995
363	38.8	STH + Protozoa	Hidayah *et al.*, 1997
149	54.8	STH + Protozoa	Sinniah *et al.*, 2010
716	73.2	STH + Protozoa	Ngui *et al.*, 2011
79	37.0	STH + Protozoa	Lim *et al.*, 2012
77	50.6	STH + Protozoa	Sinniah *et al.*, 2012
189	32.3	STH + Protozoa	Sinniah (current study)

doses of anthelminthic and not by increasing the dosage. The parasite has the ability to embed itself deep into the crypts and mucosa in the intestine to avoid action by drugs. Cases of drug resistance have been suggested but there is no strong evidence to justify this claim. In most instances, a single dose of albendazole will not give a 100% cure-rate. In heavy infections, three doses are recommended to obtain good efficacy (Ramalingam *et al.*, 1983; Sinniah & Chew, 1988; Bennett & Guyatt, 2000). Low hookworm infections reported among the urban and rural population shows that more people are becoming aware on the importance of wearing shoes to prevent hookworm infection. The overall prevalence of intestinal protozoa in this study was low compared to several earlier studies (Rajeswari *et al.*, 1994; Noor Azian *et al.*, 2007; Ngui *et al.*, 2011). The reason for decline in protozoan cases are primarily due to safe drinking water made available to more than 90% of the population in this country. Analysis of polyparasitism infection revealed that majority of the infected subjects had single parasitic infection (18.4%) followed by those with double infection (12.0%) and triple infections (1.2%). Similar mixed infections have also been widely reported in earlier studies (Lo *et al.*, 1979; Sinniah, 1984; Kan & Poon, 1987; Al- Mekhlafi *et al.*, 2007).

Orang Asli (Aborigines)

Many Orang Aslis (31%) still reside in unsafe living conditions which is conducive for the

Table 6. Prevalence of intestinal parasitic infections among slum dwellers in Malaysia 1970- 2002

No. examined	% positive	Type of parasitic infections	Authours/ Year of study
138	95.0	STH + Protozoa	Bisseru & Aziz, 1970
253	90.9	STH	Chia *et al.*, 1978
4345	53.2	STH	Kan, 1982
943	51.2	STH	Kan, 1983
3402	64.6	STH	Kan, 1983
603	58.5	STH	Sinniah, 1984
219	88.6	STH	Kan, 1984
389	64.0	STH+ Protozoa	Sinniah, 1984 (a)
2071	68.7	STH	Kan & Poon, 1987
198	65.7	STH + Protozoa	Sinniah *et al.*, 1988
1574	66.7	STH	Bundy *et al.*, 1988
159	69.2	STH	Che Ghani *et al.*, *1*989
699	57.0	STH	Kan, 1989
9863	58.0	STH	Hanjeet *et al.*, 1991
198	61.0	STH	Chan *et al.*, 1992
456	79.5	STH+ Protozoa	Rajeswari *et al.*, 1994
233	16.0	STH+ Protozoa	Sinniah *et al.*, 2002
97	20.6	STH+ Protozoa	Sinniah, (current study)

Table 7. Prevalence of intestinal parasitic infections reported in urban dwellers from 1970 to 2013

No. exam	% Pos.	Type of infection	Authours/Year
151	35.8	STH + Protozoa	Bisseru & Aziz, 1970
202	51.0	STH	Lie *et al.*, 1971
207	72.5	STH	Khan & Anuar, 1977
107	41.0	STH	Sulaiman *et al.*, 1977
305	39.0	STH	Hamimah *et al.*, 1982
7,682	50.0	STH + Protozoa	George & Ow Yang, 1982
688	75.6	STH	Kan, 1984
1,157	89.0	STH	Kan, 1984
554	27.8	STH	Sinniah, 1984
271	84.9	STH + Protozoa	Sinniah, 1984 (b)
766	24.0	STH	Subramaniam & Sinniah, 1985
111	51.0	STH	Mahendra *et al.*, 1997
159	31.0	STH	Menon *et al.*, 1999
249	76.6	STH + Protozoa	Mahmood *et al.*, 2002
246	6.9	STH + Protozoa	Jamaiah & Rohela, 2005
123	45.2	STH + Protozoa	Sinniah *et al.*, 2010

continuous transmission of intestinal parasites. For a long time, the Orang Asli led a nomadic life, living in dilapidated wooden huts along the fringes of the jungle and use the water from rivers for cooking, bathing and washing. Earlier studies showed high prevalence (Bisseru & Aziz, 1970; Dunn., 19772; Dissanaike *et al.*, 1977; Rahmah *et al.*,

Table 8. Prevalence of intestinal parasites in communities living in Flats from 1983 to 2013

No. examined	% pos	Type of infection	Authour Reference/ Year of study/ Locality of study area
2047	19.3	STH	Kan, 1983; Sri Melati Flats, Kuala Lumpur
2923	28.5	STH	Kan, 1983; Sri Pahang Flats, Kuala Lumpur
3869	7.9	STH	Kan, 1983; San Peng Flats, Kuala Lumpur
1854	35.2	STH	Kan, 1983; Shaw Road Flats, Kuala Lumpur
91	17.6	STH	Che Ghani *et al.*, 1989; Sentul, Kuala Lumpur
234	8.1	STH + Protozoa	Sinniah *et al.*, 2002, Flat Jalan Kelang Lama, Kuala Lumpur
39	5.1	STH + Protozoa	Sinniah *et al.*, 2012; Flat Kg Harun, Kuala Lumpur
56	5.5	STH	Sinniah (current study)/Sentosa Flats, Kuala Lumpur

Table 9. Prevalence of intestinal parasitic infections in fishing communities 1967-1988

No. Examines	% positive	Type of infection	References/year of study/Locality of study area
65	93.8	STH + Protozoa	Heyneman *et al.*, 1967 (Pulau Tioman)
119	98.1	STH + Protozoa	Balasinagam 1969, Pulau Perhentian Kechil, Terengganu
158	95.1	STH + Protozoa	Balasinagam 1969, Pulau Pinang
84		STH + Protozoa	Nawalanski & Roundy, 1978, Pulau Pangkor, Perak
433	76.2	STH + Protozoa	Anuar *et al.*, 1978, Pulau Pinang
210	84.3	STH + Protozoa	Subramaniam & Sinniah 1985, Pulau Carey, Selangor
297	54.2	STH + Protozoa	Sinniah *et al.*, 1988 Pulau Ketam, Selangor

1997; Norhayati *et al.*, 1997). Since the mid-nineties several studies showed a decrease in intestinal parasitic infection among the Orang Asli with prevalence rate ranging between 29.0% to 70.0% (Karim *et al.*, 1995; Noor Hayati *et al.*, 1998; Zulkifli *et al.*, 1999; Ghani *et al.*, 2002; Noor Azian *et al.*, 2007; Hakim *et al.*, 2007; Sinniah *et al.*, 2012). This decline over the last two decades was because majority of them now stay permanently in settlements equipped with basic amenities built by the government. Low prevalence rates for *G. intestinalis* (4.7%); *E. histolytica (*4.7%) and *E. coli* (2.8%) were seen in this study which is similar to that reported by other studies (Hakim *et al.*, 2007; Sinniah *et al.*, 2010). The low prevalence rate for protozoan parasites can be explained to the community-based gravity-feed water supply, piped directly to individual household within the Orang Asli settlements. Studies carried out in the Orang Asli between 1970 to 2013 showed considerable variations in the prevalence of STH infections, ranging between 29% to 100% infection rates. The reasons for high prevalence rate in these communities are due to their poor socioeconomic conditions, low standard of hygiene and greater outdoor activities. The defecating habits of the Orang Asli community

are a potential health hazard to themselves as well as to others living nearby. Those areas yet to receive these benefits showed higher prevalence. Lack of personal hygiene like not washing hands before eating and after defecation are the main factors associated with the transmission of soil-transmitted helminths. Unfortunately, many Orang Aslis do not make use of the facilities provided and instead continue to defecate indiscriminately outside their houses and in the rivers where they bathe. The prevalence rate for hookworm has decreased from as high as 92.8% (Dunn., 1972) and 95.0% (Dissanaike *et al.*, 1977) to as low as 8.1% (Hakim *et al.*, 2007) and 3.1% (Sinniah *et al.*, 2012). As education is made compulsory, school going children from the plantations, rural villages and Orang Asli settlements are encouraged to wear shoes thereby helping to break the transmission cycle of hookworm infection. However, low prevalence rate of hookworm still persist because of frequent contact with infected soil mainly during outdoor activities. In this study, low prevalence of *A. lumbricoides* (17.0%) was detected. This is in agreement with several other studies (Noor Aini *et al.*, 2004; Hakim *et al.*, 2007; Sinniah *et al.*, 2010; Sinniah *et al.*, 2012) that have shown prevalence rate of less than 30.0% except for Al-Mekhlafi *et al.* (2005, 2008) who showed high prevalence with more than 90.0%. Children are the principal sufferers and are also responsible for re-introduction of the parasites to the environment (Harhay *et al.*, 2010). The household incomes of most Orang Asli are below the poverty line and many are economically non-productive unskilled workers who depend on financial aid from the government. Despite the continuous efforts made by the government in improving their living conditions by providing safe homes with treated drinking water, periodic deworming treatment and health education regarding personal hygiene, the Orang Asli are still plagued with intestinal parasites and other infections mainly due to their lifestyle.

Rural and Plantation

Twenty eight published data on intestinal parasitic infections in agricultural workers and their families in Peninsular Malaysia since 1970 to 2013 showed that most of the inhabitants continued to suffer from STH infections. Desowitz *et al.* (1961) reported that infection rates are very high among communities closely involved in agricultural activities. Agricultural workers in the plantation sectors work mainly as manual labourers engaged in weeding, planting, harvesting and ploughing. Their work involves handling soil and they easily come into contact with the infective stage of the parasite and their chances of infection with intestinal parasites are extremely high. At the worksite, these workers have no access to water or sanitary toilets so they have no alternative but to defecate behind bushes or trees. The women on return from their work in the late afternoon start preparing their meals without changing their clothes or washing themselves. Eating food and feeding their children without washing their fingers properly first are a major source of acquiring intestinal parasitic infections. Food preferences such as eating raw vegetables and fruits without washing also help in the transmission of the parasites. Many estate workers use their toilets for storage and they often defecate indiscriminately among bushes and banana trees located at the back of their houses. The damp soil and lush vegetation makes conditions ideal for survival and development of STH. The situation in the plantation communities is further aggravated when both parents go to work early in the morning leaving behind the children unattended. With no parental supervision, these children find it easy to defecate around the houses and this can be a source of infection to others. The most common parasite detected among the children of agricultural workers in the present study was *T. trichiura* (28.0%) followed by *A. lumbricoides* (12.7%), hookworm (12.2%), *E. coli (*2.6%), *E. histolytica* (2.6%) and *G. intestinalis* (1.6%). The prevalence in this study was low compared to most studies conducted earlier (Bisseru & Aziz, 1970; Sinniah *et al.*, 1979; Lo *et al.*, 1979; Ramalingam *et al.*, 1983; Sinniah & Chew, 1990; Li, 1990; Thomas *et al.*, 1992). The underlying factors responsible for continuous prevalence are due to poor socioeconomic

status, overcrowded homes with poor standard of sanitation and hygiene, lack of awareness of intestinal parasitic infections, poor nutrition, nature of work and greater outdoor activities. Socioeconomic and environmental factors are stated to be responsible for transmission of intestinal parasites such as lack of cleanliness of the garden around the house, soil pollution, and location of latrine in relation to their source of water supply, unsafe drinking water, overcrowding and family income. Poor environmental sanitation and general living conditions allowed transmission and reinfection to occur easily within a short period of time. STH infections are a cause of cognitive impairment, physical growth retardation and anaemia in children. Chronic infection compounded by malnutrition attributed to poor school attendance and academic achievements resulting in high dropout rates. Studies on re-infection rates of STH (Sinniah & Dissanaike, 1980; Cabrera *et al.*, 1980; Henry, 1988) in populations treated with anthelmintic showed that reinfection was quite rapid. Children became re-infected within 4 months indicating that treatment alone is insufficient in eliminating the problem. It was stated that sanitation and crowding were significantly associated with re-infection with *A. lumbricoides and T. trichiura.* Transmission of intestinal parasites can be eliminated by health education, provision of sanitary facilities, better healthcare, better homes and improved income. Earlier studies showed that the prevalence of intestinal parasites fluctuated from as high as 95% (Lo *et al.*, 1979) to as low as 37.3% (Lim *et al.*, 2012). Since the 1990s, several studies showed a steady decline between 32.0% to 50.0% (Sinniah *et al.*, 1992; Hidayah *et al.*, 1997; Lim *et al.*, 2012). Soil-transmitted helminths still remain a major public health problem among the rural population especially those involved in agriculture despite efforts made to improve the healthcare and socioeconomic status of the rural community.

Urban Slum Dwellers

Communities in urban slums consist of mixed group made of local residents, migrants from rural areas and legal or illegal immigrants from neighbouring countries living as a community. However, it is not unique in Malaysia to see small businessmen, fairly well educated people, students, government civil servants, self-employed and others living in slum settlements. Currently, most slum dwellers in Malaysia enjoy better environmental sanitation and have access to well organized primary healthcare services particularly for women and children. However, in several low and middle-income countries, urban migration has led to the creation of squatter settlements with high rates of polyparasitism. Since 1970, several studies conducted in Malaysia have reported high prevalence rate of intestinal parasitic infections ranging from 53.2% to 90.9% (Bisseru & Aziz, 1970; Chia *et al.*, 1978; Sinniah, 1984; Kan, 1984, Bundy *et al.*, 1988; Rajeswari *et al.*, 1994) among slum dwellers in Malaysia. In the current study, low prevalence rate for intestinal protozoan infection which is similar to an earlier study done by Sinniah *et al.* (2010) was shown. Low level of protozoan parasites indicates safe-water supply to the slum dwellers. No cases of hookworm were detected in this study. No case of hookworm suggests that wearing footwear has eliminated or decreased hookworm infections. However there were low prevalence of *T. trichiura* (13.4%) and *A. lumbricoides* (12.4%) infections. The prevalence were smaller in numbers compared to previous studies (Sinniah, 1984(b); Kan & Poon, 1987; Bundy *et al.*, 1988; Rajeswari *et al.*, 1994). Presence of soil-transmitted helminths such as *A. lumbricoides* and *T. trichiura* indicate lack of good hygienic practices and poor sanitary conditions. Many cities in developing countries such as Malaysia are undergoing rapid urbanization due to industrialization. The sudden, uncontrolled influx of illiterate and unskilled rural population as well as immigrants from neighboring countries has resulted in overcrowded cities and growth of mega-slums in many developing countries. Both the migrants and the long established slum dwellers carry the burden of intestinal parasitic diseases because city authorities are overstretched in the provision of services

such as water supply, sanitation, garbage disposal and healthcare due to meager resources (Crompton & Savioli, 1993). According to Harphan & Stephens (1991), about a third of the urban population in developing countries will live in slums by the year 2000 and as many as 2,200 million people will reside in cities. The urban slum dwellers in Malaysia are better off compared to other countries because in Malaysia, the local authorities have targeted "zero slum settlements" by the year 2020. As such, the authorities have embarked on a comprehensive urban housing scheme to relocate the slum dwellers. Slums are being replaced by multi-storey low cost apartments equipped with clean water supply, sanitation and electricity. The government started re-locating slum dwellers into high-rise flats by making available loans with low interest to purchase the property over a period of 45 years. In some cases, squatters are given the flats free or at a minimal payment as an incentive to move them out of the area which are later converted for commercial development. Over the past 42 years, the prevalence of parasitic infections among slum populations fluctuated between 32.5% to 90.9% (Chia *et al.*, 1978; Kan, 1984; Subramaniam & Sinniah, 1985; Bundy *et al.*, 1988; Hanjeet *et al.*, 1991; Mahmood *et al.*, 2002; Sinniah *et al.*, 2010). Lately, a decline is seen mainly due to interventions by the government to provide safe-water directly to houses or by providing community stand-pipes, community health education, compulsory schooling for children and other amenities like electricity, roads, and regular garbage collection were instituted to improve the quality of life of these residents. Slum dwellers have easy access to purchase anthelmintic at affordable prices. Despite these efforts, intestinal parasites still persists because many squatters both local and migrants return to the irrespective villages or countries at the end of Muslim fasting month to be with their families. Similarly, many Chinese too return to their parent's home in new villages or smaller towns to celebrate Lunar New Year. These people who return to the rural areas during festival seasons are at risk of acquiring infection and become a source of infection to others on their return. Published data over the past 42 years provide sufficient data to indicate that parasitic infections are endemic in the squatter areas due to poor socioeconomic status, environmental conditions and continuous migration of people that help maintain transmission of parasitic infections.

Urban Dwellers

The studies on urban dwellers were mainly carried out on hospital patients, population from the lower middle class communities, and new villages within the urban municipalities with better sanitation, health and medical facilities but still showed a prevalence rate ranging from as high as 72.5% in 1977 (Khan & Anuar) to as low as 6.9% in 2005 (Jamaiah & Rohela). Most of the sixteen studies were done before 2000 and as such it is difficult to come to a conclusion on the present status. More in depth studies need to be carried out in the urban population to determine the current status.

Flat dwellers

The current study showed that the prevalence of intestinal parasitic infections among flat dwellers (5.4%) are markedly less than in the plantation (32.3%) and slum dwellers (20.6%). In 1983, Kan reported varied prevalence rates among flat dwellers in several areas in Kuala Lumpur with 19.3% in Sri Melati,28.5% in Sri Pahang, 7.9% in San Peng and 35.2% in Shaw road. Che Ghani *et al.* (1989) stated that when squatters (81.2% with STH) were re-located into flats, the prevalence rate decreased substantially (8.8%) within a year of shifting out from slum areas. In the same study, the prevalence rate of children who had combination of STH and protozoa dropped from 83.2% to 17.6% within a period of one year of shifting into flats. In 2002 and 2010, prevalence rates of 8.1% and 5.1% was reported (Sinniah *et al.*, 2002; Sinniah *et al.*, 2010) in flat dwellers in Kuala Lumpur which is less than that reported in all the earlier studies. The results of the few studies (Kan, 1983; Che Ghani *et al.*, 1989; Sinniah *et al.*, 2002 & 2010) indicate that there is a substantial decrease in the prevalence rate in flat dwellers depending on the duration

of their stay in the flats after moving from squatter areas. Decreases in intestinal parasitic infections among flat dwellers are due to being better equipped with modern amenities with no area where helminth ova and protozoan cysts can survive. The only other possible source of infection may be through purchase of food from unhygienic hawker stalls. This study agrees with Kleevens, (1966) and Che Ghani *et al*. (1989), that when squatters moved to flats or to modern homes the level of infection decreases rapidly over time. Hookworm and *Strongyloides stercoralis* once endemic in the urban areas of Malaysia are almost non-existent.

A review of one hundred and one published articles on intestinal parasitic infections conducted over four decades, on various communities living in different habitats in Malaysia showed diverse results. Some studies focused solely on soil-transmitted helminths whilst others researched only on intestinal protozoan infections and the rest included both. Besides that, differences in sample size, age groups, diversity of the population, selection criteria of the respondents made it difficult to determine the overall prevalence of intestinal parasites among the general population in Malaysia. However most of the studies confirmed that intestinal parasitic infections continue to be a public health problem especially among the marginalized communities such as the Orang Asli followed by those involved in agricultural activities. Occupation, source of water, human behavior, environmental sanitation and lifestyle are the most likely factors contributing to the transmission of intestinal parasites. Limitation to majority of the studies was that only a single stool examination was done and cases of low infections may be missed resulting in underreporting. Secondly although studies show a decrease in prevalence rate since 1970, it is unclear if these infections are still prevalent among communities who were examined and treated earlier as no follow up studies were conducted. Malaysia has improved its socioeconomic status which helped contribute to poverty reduction. However there are many challenges related to neglected tropical diseases that need to be addressed. There is a need for political commitment with provision of adequate resources, to develop a surveillance and evaluation system to monitor progress of the control programmes for communities at risk and that needs to be developed. Community based programmes and social mobilization are vital for the elimination of intestinal parasitic infections. In partnership with government and other agencies the Millennium Development Goals are achievable by Malaysia as it strides to become a developed nation by 2020. Since the eighties Malaysia has moved to become a new industrialized country. Based on the findings of these studies, intestinal parasitic infections can be controlled by making changes in their living conditions and environment. Failure to improve the problems of intestinal parasites among the impoverished communities will hinder the achievement of the Millennium Development Goals for this country.

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